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Delivering Laser-Driven Proton Beams to Biological Samples at BELLA iP2

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Laser-driven ion accelerators (LDIAs) generate high-intensity beams, offering immense potential across various applications, including investigating ultra-high dose rate radiobiological research. The significant beam divergence of laser-driven proton beams at the source requires capture and transport of these beams to maintain a high particle intensity at the sample site located outside the main target chamber. At the BELLA Center's iP2 beamline, we have deployed two beam transport configurations, leveraging permanent magnets for compactness, to reliably deliver up to 30 MeV protons to biological samples at high particle intensities. In conjunction with these setups, a comprehensive suite of diagnostic tools was implemented for dosimetry tasks, including multiple integrating current transformers (ICTs) for indirect online dose measurements and calibrated radiochromic films (RCFs) to measure the dose distribution and calibrate the ICTs. With the use of Monte Carlo simulations of the beamline, we achieve accurate dose estimates applied to the samples, while accounting for the linear energy transfer (LET)-dependent response of RCFs. The proton beam transport was successfully used for in vivo biological sample irradiations and is available to future users of BELLA iP2.

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